



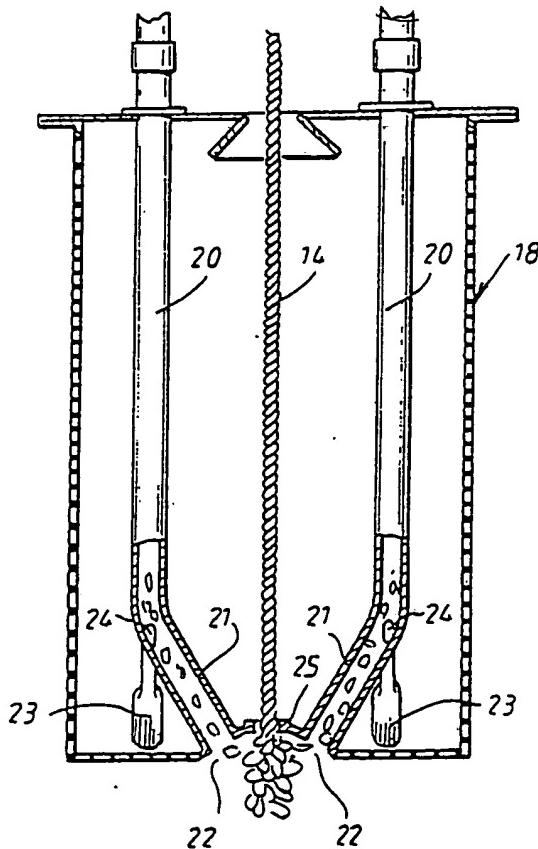
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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## (54) Title: IMPROVEMENTS IN OR RELATING TO MUSSEL CULTURE

## (57) Abstract

This invention provides for the growing of molluscs (generically "mussels") on ropes supported in the sea or other suitable body of water. A rope upon which the desired growth has been allowed to accumulate is winched vertically upwards through a region in which mussels are stripped from the rope. In this region there is forced or induced an upflow of water which entrains mussels and removes them for "mussocking" in the case of "spat" or baby mussels or, in the case of fully grown mussels, for such "de-clumping" grading and other known operations as are needed to make them ready for the market. The invention also provides a mussocking process i.e. a process for packing spat mussels into an elongated tubular net or "sock" for subsequent immersion and growth into mussels harvestable for the market.



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IMPROVEMENTS IN OR RELATING TO MUSSEL CULTURE

This invention relates to the pisciculture of mussels and other molluscs (referred to generically hereinafter as "mussels") including the growing of salt-water mussels on ropes supported or suspended in the water and periodically hauled in for the collection of mussels therefrom.

More especially the present invention relates to the cultivation of mussels from seed or "spat" mussels ("baby" mussels) which are "mussocked" at an appropriate growth density into a tubular net or sock to form an elongated linear structure resembling and sometimes referred to hereinafter as a "sausage". In time the sausage forms a growth of commercially harvestable mussels.

Some nets known and used hitherto have been of a type designed to rot away after a relatively short time. Another type of net, and one which may be considered more appropriate for present purposes, is of a material which remains relatively intact, its mesh being generally wide enough to allow mussel growth to migrate to the outside of the sock.

For the purposes of this specification such a linear growth element, be it e.g. a mussocked "sausage", or an ordinary rope for spat growing purposes, is sometimes referred to generically as a "growth rope".

In the past the mussocking operation i.e. the placing of spat into the net or sock, has often been tedious and time-consuming.

An object of the invention is to provide for mussocking by an operation which is quick, efficient and easily controllable.

At this point it may be noted that the cultivation of mussels for the market is essentially a four-stage operation:

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1. The culture (growing and collection) of spat;
2. Mussocking the spat;
3. The nurture or "care" stage, and
4. Harvesting.

5 Conventionally, spat is grown on lines individually weighted and suspended vertically at intervals from a horizontal "long-line" supported at or near the surface of the water where it is buoyed by floats. Alternatively, a submerged long-line can be  
10 anchored by weights resting on the sea-bed and supported by submerged buoys or other suitable hydrostatic devices. A typical growth-rope, therefore, has usually been shorter than the water-depth.

15 Sometimes short "skewers" are inserted in the growth rope at intervals along their lengths. The function of the skewers is to inhibit detachment of the spat from the rope. Mussels have been harvested by hauling in the vertical lines individually and removing the growth by hand, either in the boat or, at a later  
20 stage, on shore.

This, however, can be onerous, wasteful, cumbersome and time-consuming. Although the ropes are submerged, their weight - when they have accumulated even a moderate growth of mussels - can be substantial.  
25 Furthermore, the slightest lack of care in pulling in the rope can result in loss by dislodgement of clumps of less-firmly attached mussels.

Another object of the invention, therefore, is to facilitate and improve the efficiency of mussel farming by making harvesting, rope - stripping, breaking-off skewers, "de-clumping", grading and rope-cleaning a substantially simultaneous and automated operation.

30 A further object is to produce high-quality mussels more cheaply and/or in greater quantities than  
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has generally been possible heretofore.

Yet another object of the invention is to produce mussels by a quick and convenient operation which is labour-saving and requires no complex machinery or highly-skilled operators.

Other objects and advantages will become apparent hereinafter.

According to the present invention in one aspect, a method of mussel culture in a marine or other aqueous environment supportive of mussel growth, comprises providing a growth rope or line, positioning said rope wholly or substantially beneath the surface but above the bed of the water, keeping the rope in such position long enough to provide a desired mussel growth, and thereafter removing said growth from the line, characterized by effecting said removal from an immersed part of the line in a stripping region by pulling up the line in a substantially vertical direction through said region with consequent stripping of material from the rope therein, and establishing a régime of water upflow in said region while growth is detached by and/or within said régime, said flow entraining mussels removed from the line which are carried away for subsequent handling.

But in order that the invention may be better understood, reference will now be made to the accompanying drawings which are to be considered as part of this specification and read herewith. In the drawings:

Fig. 1 is a diagram showing how a growth line can be supported from a long-line for the development of either spat or fully-grown mussels in stage 1 or 3 respectively of the operation referred to above;

Fig. 2 is a side view of a mussocking apparatus for carrying out stage 2 in a system according to a practical embodiment of the invention;

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Fig. 3 is a top plan of a mussocker head comprising a triplex suction unit for removing spat from a rope upon which it has been grown in stage 1 and for conveying it to a total of six mussocking units  
5 (stage 2);

Fig. 4 is a section across line 4-4 in Fig. 2;

Figs. 5 and 6 are, respectively, sections across lines 5-5 and 6-6 in Fig. 4;

10 Fig. 7 is an enlarged view of portion of the apparatus shown in Fig. 2, with particular reference to the formation of a mussocked "sausage" of required diameter and/or density;

15 Fig. 8 is a side-view diagram of a harvesting apparatus (stage 4) including "de-clumping" and grading stages, and

Fig. 9 is an axial section through the harvester head of the apparatus shown in Fig. 8.

Referring to the drawings in more detail,  
20 Fig. 1 generally illustrates a possible disposition and manner of supporting or suspending a growing rope either in stage 1 or stage 3 of the four-stage operation referred to above. That is to say, the disposition shown in Fig. 1 may be found appropriate either for the growing of spat, which forms part of  
25 stage 1, or for the growth of mussels in a mussocked line, to the point at which they are ready for harvesting in stage 4.

Therefore, applied to stage 1, Fig. 1 is a general illustration of the culture of spat for subsequent use in the manner of "seed" for the growth of mussels harvestable for the market. Accordingly a suitable section 10 of sea is selected. Long-line 11 of a "floating" type referred to above is suspended horizontally just beneath surface 12 by means of buoys  
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13. A suitable growth rope 14 skewered, fitted with  
long-line fastenings 15 and weights 16, is coiled on a  
reel and taken to the "farm" i.e. the part 10 of the  
sea already selected, where it is hung from long-line  
5 11 by said fastenings 15, between which it is weighted  
by 16 at positions well clear of the sea-bed.

Rope 14 forms a long, continuous growth basis  
the length of which will usually be substantially  
greater than growth ropes used in the past, and will  
10 usually be limited only by such mechanical and power  
limitations as are inherent in the winch and other  
parts of the system to be more fully described herein-  
after.

If desired, a very long growing rope can be  
15 suspended zigzag-wise from two or more horizontally-  
spaced parallel long-lines, by fastening to the lines  
in succession.

The collection and mussocking of spat will  
now be described with general reference to Fig. 2 and  
20 particular reference to Figs. 3 to 7 inclusive.

The apparatus may be mounted on a boat, or a  
floating rig or platform which can be towed to and from  
the farm, or in any other suitable manner.

A growing rope with its accumulation of spat  
25 14 is severed as required and unfastened from long-line  
11. One end 17 of the rope is threaded through  
mussocker head 18 and secured to the drum of a winch  
(not shown). As best seen in Figs. 4 to 6, mussocker  
30 head 18 incorporates three groups each of three tubes  
or conduits through which water is pumped at a speed  
which generally is related to the winch speed and to  
the rate of mussocking. Each group of conduits  
functions identically. A typical group consists of a  
central tube 19 and two side tubes 20. Each side tube  
35 has a main upper portion parallel to the central tube,

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and a lower inclined portion 21, as best seen in Fig. 5, opening into a spat-removal region 22. As best seen in Fig. 6, the bottom of the central tube divides into two U-branches 23 which respectively join the side tubes via ports 24 at the conjunctions between the axial and inclined portions of those tubes. When mussocking head 18 is submerged as shown in Fig. 2, sea-water is pumped down the central tube of each group and returns via the side tubes to the top of head 18. The flow passing ports 24 creates a Venturi suction effect which induces upflow from region 22 via tubes 21.

The flow régime induced in region 22 may be assisted by a conical funnel (not shown) which converges the upflow and may itself cause some dislodgement of spat, but the stripping of rope 14 results chiefly from scraping e.g. by drawing the rope through a narrow pipe, tube or "extrusion core" 25 axially located in the base of 18. Advantageously the core is only just wide enough to accommodate passage of the rope (and, possibly, any weights and fastenings attached thereto) but narrow enough to cause otherwise substantially complete stripping including breaking off skewers from the rope. All of this material, being dislodged in region 22, is sucked upwards through 21 into the main flow in tubes 20, which flow forces it into sock 26 for producing mussocked formation 27.

It will be seen from Fig. 3 that the triplex system 18 produces a total of six "spat flows" (which term includes such additional matter as skewer pieces, sea-weed etc. as were dislodged from 14) in pipes 20. The spat flows are turned from a vertical to a horizontal direction in which they proceed to six mussocking units. A typical unit is now described.

35 Sock 26 is a tubular net closed at its

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forward end 28, to which is tied the end of rope 29. The sock, which in a "bunched up" condition is placed over the end portion of pipe 20, is progressively filled usually to a diameter of about 5 cm. with a spat 5 packing linear density of about 1000 per metre, but the invention allows these parameters to be varied to a limited and strictly controlled extent.

Pipe 20 ends in guide 30 which may be of open-mesh structure and turns the progressively formed 10 mussock from a horizontal to a downward direction so that its progress is to some extent, gravity-assisted. Rope 29 winds off free-wheeling reel 31 and passes along a subsidiary tube 32 which ends just behind guide 30 where both sock and rope are received into the guide 15 as shown in Fig. 7 through the annular space between the mating ends of 20 and 30.

As the spat flow enters sock 26, its pressure progressively pulls the bunched-up sock off pipe 20 and 20 over tensioning collar 33, which is slidable on the pipe. When moved to the left or right it tends respectively to increase or decrease resistance to passage of the net from pipe 20 to guide 30. Water can be removed from the flow by extractor or drainer 34.

In use, the net tension is suitably matched 25 to the rate of flow of spat through 20, which will depend, in turn, upon the rope winching speed and/or pumping rate of water in the mussocker head and/or rate of water removal through 34. All four parameters are adjustable to provide a mussocked structure packed to 30 the desired density.

Referring now to Figs. 8 and 9, harvester head 35 constitutes a housing for pipes 36 down which water is pumped to return through suitably directed passageways as an upflow régime where mussock rope 29 35 is being pulled vertically through unit 35, which .

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lastmentioned may be done by winching, in like manner to spat rope 14 through mussocker head 18. The rope may be stripped of mussels and other matter at any convenient stage of the upflow e.g. where rope 29 exits from tube 37 where the mussel flow is turning from vertical to horizontal and thence to "de-clumper" and grader stages 38 and 39 respectively of a kind known per se.

10 The upflow entrains the mussels and foreign matter dislodged from the rope and, in particular, tends to prevent dislodged mussels from dropping to the sea-bed.

15 The winch may be located in a housing vertically above the end portion of the conduit with the tube passing vertically out of the conduit at the bend thereof, as shown. Alternatively the winch could be located "downstream" of the grader. However the former embodiment may be preferred because the rope does not have to be winched around bends.

20 To enable the winching operation to be commenced, an upper part of the growing-rope must be clear of growth and skewers so that it can be threaded into the tube and thence into the winch chamber for connexion to the winch itself. Otherwise a feeder rope can be attached to the end of the growing line for the purpose of starting the winching operation. The current established, the winch may then be started, thereby pulling the rest of the rope into and through the harvester head, whereby mussels, skewers etc. are dislodged from the rope and thereby freed for entrainment into the current and conduction thereby into the declumping, grading and whatever other final operational stages are desired.

35 "Clumps" of mussels may be broken up by passing the current and entrained mussels through unit

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38 of a known type, including a drum having a suitable arrangement of transverse pegs, baffles or the like. The conduit may enter the drum coaxially so that the drum can be rotated relatively thereto e.g. by a 5 turbine action of water pressure from a by-pass from the pump or some other means. The declumped mussels may thereafter pass to a known type of rotatable grader drum 39 co-axial with the declumper.

The apparatus can also be used to clean long-lines of mussels after the growth rope has been 10 removed. This can be done by adding a flexible hose to the intake conduit and using the hose after the manner of a suction cleaner to clear the long-line of mussels. This means that these mussels now become economically 15 harvestable and the long line can now be easily and quickly cleaned.

The invention makes possible the harvesting of commercial quantities of mussels of closely controlled quality, and may reduce the need to dredge 20 mussels from the sea-bed where they are likely to be affected by silt and other undesirable substances.

The invention also enables what would previously have been a considerable number of separate growing-ropes to be combined into a single growing 25 line, possibly of length substantially greater than the water-depth, pegged at suitable intervals to a horizontal beam, "long-line" or the like supported below the water-level, and appropriately weighted so as to assume the required attitude in the water. To harvest the 30 mussels, it suffices to fix a free end portion of the rope to the winch, as aforesaid, to start the pump, to cut or unpeg the growing line, and to start the winch.

The invention also makes mussel-harvesting, 35 in effect, a one-man operation. It eliminates the considerable effort of lifting and hoisting in the

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ropes weighted down with a substantial growth of mussels, and avoids the wastage due e.g. to accidental dislodgement and loss of mussels, that often attends hand-harvesting operations. Furthermore, it enables the handling of much longer growth ropes than have been generally possible heretofore.

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The claims defining the invention are as follows:

1. A method of mussel culture in a marine or other aqueous environment supportive of mussel growth comprising providing a growth rope or line, positioning said rope wholly or substantially beneath the surface but above the bed of the water, keeping the rope in such position long enough to provide a desired mussel growth, and thereafter removing said growth from the line, characterized by effecting said removal from an immersed part of the line in a stripping region by pulling up the line in a substantially vertical direction through said region with consequent stripping of material from the rope therein, and establishing a régime of water upflow in said region while growth is detached by and/or within said régime, said flow entraining mussels removed from the line which are carried away for subsequent handling.
2. A method according to claim 1 of collecting spat mussels for subsequent growing, wherein said water flow régime is induced by Venturi means into a main flow conduit in the vicinity of the region.
3. A method according to claim 2 wherein spat removed from the line is conveyed to a mussocking stage to produce a mussocked growth rope.
4. A method as claimed in claim 1 of harvesting mussels grown from a mussocked rope wherein said flow régime is produced by pumping water into said region through suitably directed passageways and said flow with mussels and foreign matter entrained therein is conveyed to de-clumping and grading stages.
5. Mussels produced by the process according to any one of the preceding claims.
6. A method of producing a mussock consisting essentially of spat mussels packed into a sock in the form of a tubular net closed at a forward end and being

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of mesh size sufficiently small to hold a mussocked structure of said spat of required diameter and packing density, characterized by providing a guide tube of internal diameter substantially equal to said required diameter, a spat supply pipe having a forward end terminating within a rear end portion of the tube, placing the sock in a folded or bunched condition over said forward end of the sock extending into the guide through an annular space between said mating end portions of the guide and tube, and establishing a spat flow through the tube into the guided sock which is thereby progressively packed with spat and advanced through and out of the forward end of the guide to produce the required mussocked structure.

7. A method as claimed in claim 6 wherein a mussock rope fixed to the forward end of the sock and disposed substantially axially therein is progressively fed to the mussock as the lastmentioned is formed and advances through the guide.

8. A mussocked structure produced by claim 6 or claim 7.

9. Apparatus for the culture and/or harvesting of mussels, including winch means for pulling in a growth rope in a substantially vertical direction past scraper means for removing growth from the rope, pump means for producing an upflow régime of water capable of entraining mussels and other matter removed from the rope, and conduit means for carrying away said flow and material for subsequent handling.

10. Mussels cultured and/or harvested using the apparatus for claim 9.

11. A method of mussel culture substantially as herein described with reference to the accompanying drawings.

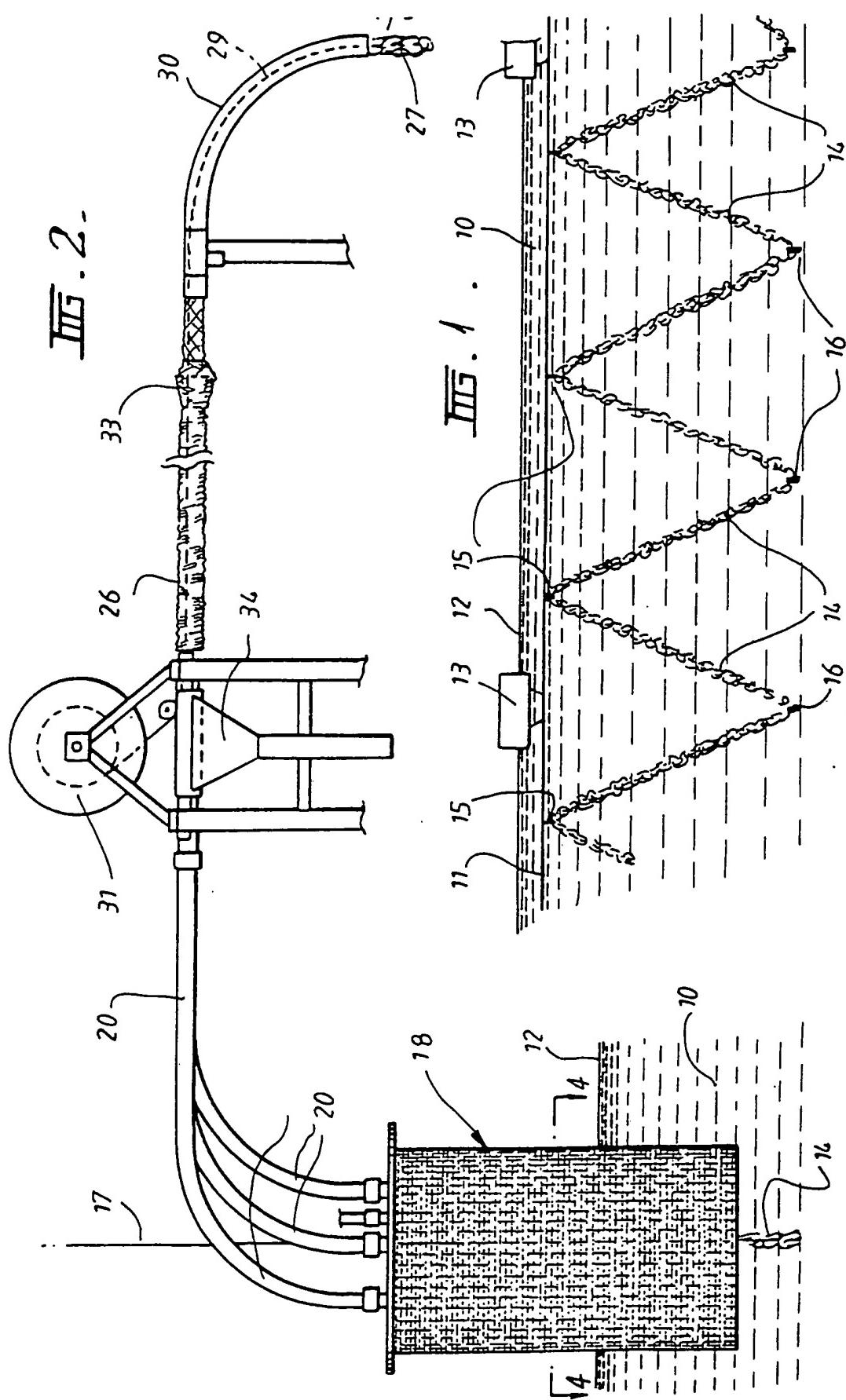
12. A method of producing a mussock substantially

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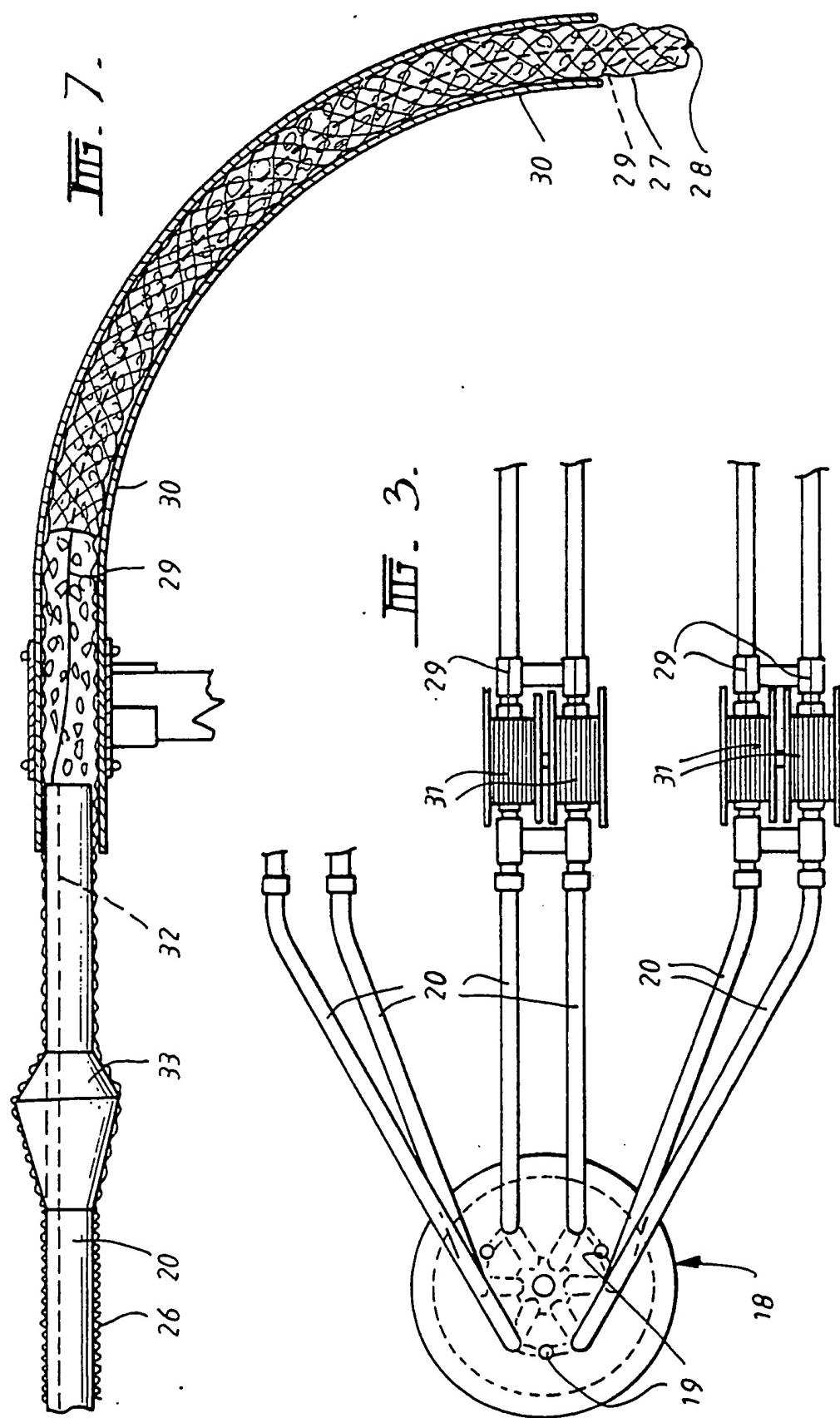
as herein described with reference to the accompanying drawings.

13. Apparatus for the culture and harvesting of mussels, substantially as herein described with reference to the accompanying drawings.

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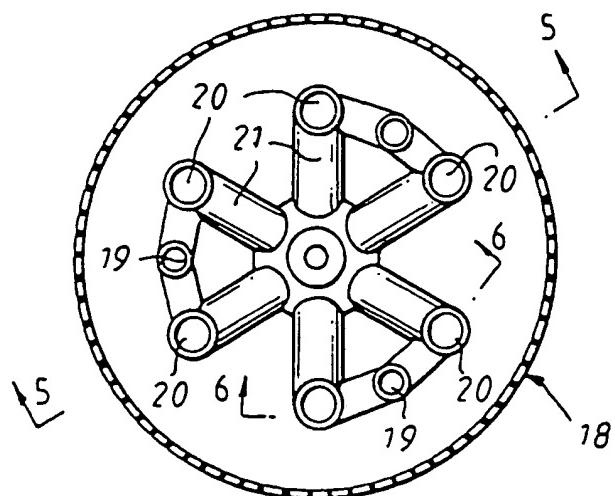
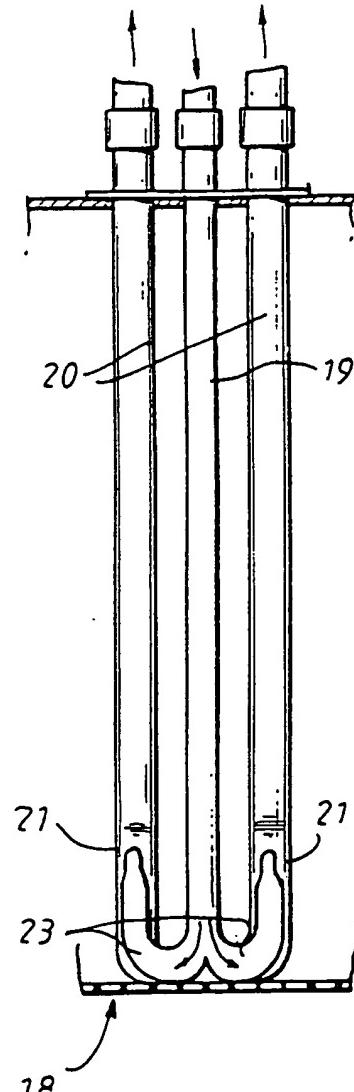
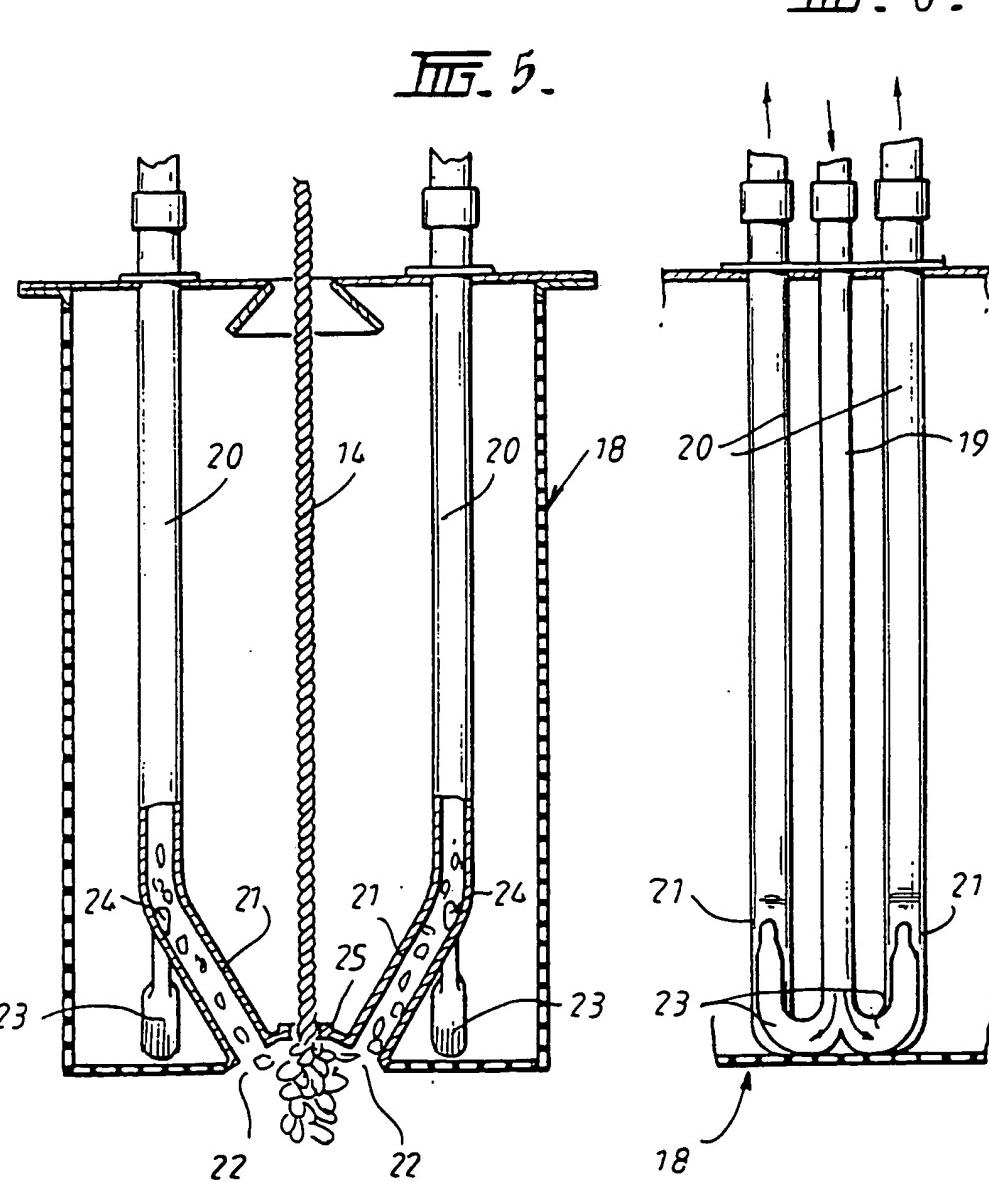
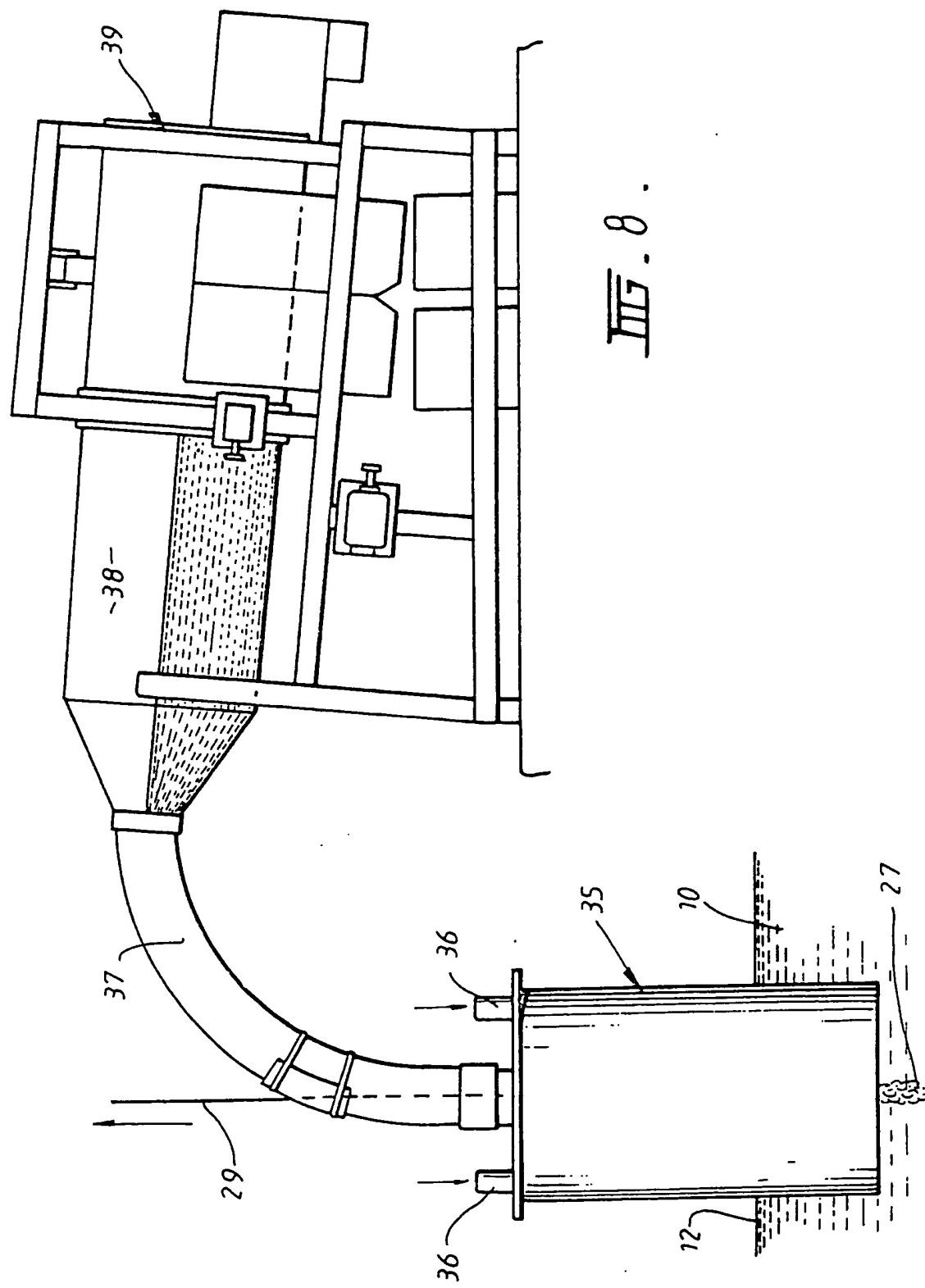


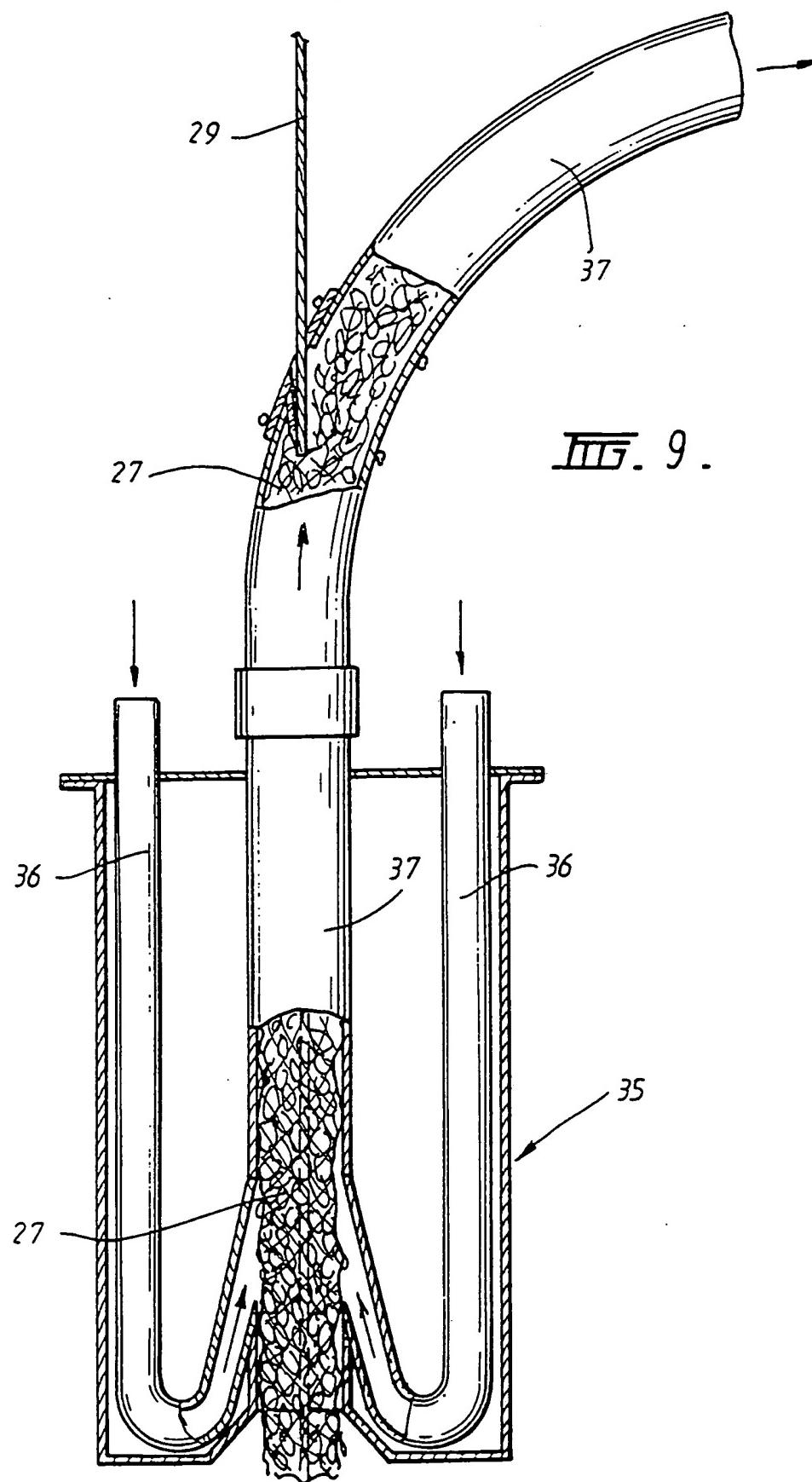
FIG. 4.



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# INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 87/00388

## I. CLASSIFICATION OF SUBJECT MATTER (If special classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl. <sup>4</sup> A01K 61/00; A01K 80/00

## II. FIELDS SEARCHED

Minimum Documentation Searched \*

Classification System	Classification Symbols
IPC	A01K 61/00; A01K 80/00

Documentation Searched other than Minimum Documentation  
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## III. DOCUMENTS CONSIDERED TO BE RELEVANT\*

Category **	Citation of Document, *** with indication, where appropriate, of the relevant passages ****	Relevant to Claim No. *****
A	US,A, 3811411 (MOELLER) 21 May 1974 (21.05.74)	
A	US,A, 2922393 (MUNZ) 26 January 1960 (26.01.60)	
A	FR,B, 1360273 (MAHEO) 31 March 1964 (31.03.64)	

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## IV. CERTIFICATION

Date of the Actual Completion of the International Search

14 January 1988 (14.01.88)

Date of Mailing of this International Search Report

(2701-88) 27 JANUARY 1988

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